

**CLAIMS**

1. A method of manufacturing a photonic integrated circuit comprising a compound semiconductor structure having a quantum well region, comprising the steps of irradiating the structure using a source of photons to generate defects, the photons having an energy ( $E$ ) at least that of the displacement energy ( $E_D$ ) of at least one element of the compound semiconductor, and subsequently annealing the structure to promote quantum well intermixing.

2. A method according to claim 1, in which the radiation source is a plasma.

3. A method according to claim 2, in which the plasma source is generated using an electron cyclotron resonance (ECR) system, an inductively coupled plasma (ICP) system, a plasma disk excited by a soft vacuum electron beam, or plasma soft x-ray (SFR) devices.

4. A method according to claim 1, in which the radiation source is one selected from a group consisting of electrical gas discharge devices, excimer lasers, synchrotron devices, flash x-ray devices and gamma ray sources.

5. A method according to any preceding claim, including the step of masking a portion of the structure to control the degree of radiation damage.

6. A method according to claim 5, in which the mask is adapted to prevent intermixing entirely.

7. A method according to claim 5, in which the structure is masked in a differential manner to selectively intermix the structure in a spatially controlled manner by

controlling the exposure of portions of the structure in a predetermined manner.

8. A method according to any of claims 5 to 7, in which  
5 the mask is selected from a group consisting of binary  
masks, phase masks, gray masks, dielectric or metal masks,  
and photoresist masks.

9. A method according to any preceding claim, in which  
10 spatial control of intermixing is controlled using a  
variable profile mask pattern.

10. A method according to any preceding claim further  
comprising the steps of forming a photoresist on the  
15 structure and differentially exposing regions of the  
photoresist in a spatially selective manner in dependence  
on the degree of quantum well intermixing required, and  
subsequently developing the photoresist.

20 11. A method according to claim 10, comprising the step of  
applying an optical mask to the photoresist and exposing  
the photoresist through the optical mask, the optical mask  
having an optical transmittance that varies in a spatially  
selective manner.

25 12. A method according to claims 11, in which the optical  
mask is a Gray scale mask.

30 13. A method according to any of claims 10 to 12, in which  
the photoresist is applied to a masking layer.

14. A method according to claim 13, in which the masking  
layer is a dielectric.

35 15. A method according to claims 13 or 14, further  
comprising the step of etching the structure with the

developed photoresist in situ to provide a differentially etched masking layer.

16. A method according to any preceding claim, in which an  
5 electron cyclotron resonance system is used to generate a plasma, wherein the microwave power of the ECR system is between 300 and 3000 W, more preferably between 1000 and 2000 W, the process temperature is between 25 and 500°C, more preferably between 25 and 200°C, the process pressure  
10 is between 0.1 and 100 mTorr, more preferably between 20 and 50 mTorr, and the exposure time is between 30 seconds and 1 hour, more preferably between 4 and 14 minutes.